Sustainable Architectural Applications in the Gulf States-Post Occupancy Evaluation Case Study of Kingdom of Saudi Arabia

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Abstract

This study aimed at studying, analyzing, and assessing sustainability experiment in KSA through estimating buildings established and designed in many sites at the kingdom. But these buildings were analyzed from the descriptive method, in addition to extracting special standards through the users of these buildings. The opinions of the users were taken through a questionnaire for extracting the satisfaction level about the sustainable buildings in KSA. Above all, meetings with the people of specialty who designed the buildings were held and compared before and after design, together with the method of visualizing the subject. The study considered all elements and terms used in order to extract some helpful results for the decision makers, together with putting strategies and an approach for designing the sustainable buildings in the kingdom. The findings indicated that the user is affected by the sustainable measures taken in designing and construction of these buildings. Many factors affected the satisfaction level of the users including the cultural, social and economic factors.

Keywords: Sustainable architecture in Saudi Arabia, Green architecture, User satisfaction with Sustainable Architecture.

1. Introduction:

Although the numbers and facts that remark the increase in the level of the environmental pollution all over the world as a result of urbanization, some evidences refer that the percentage of the building wastes resulted by the activities of building and destroying has been increased all over the world with 20% - 42% of the total of the wastes. In addition, the pollution resulted by warming and cooling of the internal environment of the buildings is more than the pollution resulted by the vehicle exhaust even in the United States of America that 40% of carbon dioxide is resulted by its buildings contrary to the building of the sustainable architecture. According to the Arab Institute for Developing Cities; the percentage of the structural wastes of the total wastes in 1986 was 78%. (1)

Studies showed that the average of electricity consumption of the buildings that are based on the sustainability in their structure is less than 70%, and their water consumption is less than 50 % to 60%, while their energy consumption is 36% (2).The structure sector consumes 40% of the world power energy in excluding, manufacturing, transporting and building the houses with annual cost 400 billion dollars, the matter that results in the emission of carbon dioxide as a result of burning of the fossil fuel which led to the appearance of the global warming of the earth away from producing wastes that are not recycled or melted, in addition to the leakage of poisonous materials and harm emissions from the processes of excavation and construction. (2)

Despite of these numbers and facts, some evidences refer that the sustainable architecture in the Kingdom of Saudi Arabia is not sufficiently developed to be compared to the developed countries. In 1994, statistics of the Ministry of Municipal Affairs indicated that the percentage of the structuring wastes reached 45 % of the total wastes all over the Kingdom of Saudi Arabia; adding to that the architectural applications that take care of the sustainable architecture usage of classical techniques like wind catchers or roof planting, but they do not perform their works as required. It is noteworthy to state that the motivation that necessitates us to take care and apply the principles of the sustainable architecture is that the resources of the Kingdom of Saudi Arabia are considered to be little and the energy resources of the kingdom do not last longer, as the Saudi individual consumption rate of the energy is 5215 Kilo Watt, which is considered to be high. This necessitates us to search for new alternatives for the traditional energy, together with all other factors that invite us to stop and review the value of the sustainable architecture in the Kingdom of Saudi Arabia. (3)

Above all, the Saudi Government has made great efforts and attempts to support and encourage this design schema in the Kingdom of Saudi Arabia after the modern architecture has proved its negative effects by depending on international standards that are not suitable to the Kingdom of Saudi Arabia. These efforts and attempts resulted in some sustainable architecture in Saudi Arabia, but they do not reach the required level comparable to the other international projects, though they considered to be a step forward; like the buildings of the Ministry of Education, the construction market and the General Authority for Tourism and Archaeology that has been adapted to the Saudi environment and expressed its social traditions. (4)

It is noteworthy to state that the Kingdom of Saudi Arabia has lots of available natural resources that the architects may use in a modern way and manipulate for the benefits of the environment like the wind and the solar rays that play a big role in providing the buildings with the electricity power, and helping in cooling the buildings which allow the exploitation of the other traditional energies. This is due to the fact that the old classical architecture in the Kingdom of Saudi Arabia was taking into account the characteristics of the surrounding environment in a way that makes us see the Eastern Region's wind catchers in which some architectural treatments have been done in order to get benefit of the air (4).

But for the Middle Region, the building was looking inwards to an internal shaded playground which provides the inhabitants with a relaxed atmosphere. Whereas in the Northern Region, we can see them use natural materials taken from the location of the site, which may lead to decrease of the level of the global warming found in the concrete and cement. This is

applicable to the rest of the regions of the Saudi Arabia as a whole, as the buildings were structured and designed according to the nature of the site, the climate and the social traditions. But these values and systems used in the past have been gradually deteriorated, and no longer taken into account as a result of the international urbanization of the Kingdom of Saudi Arabia, and the financial availability that does not like to pay money in applying the principles of the sustainability over their projects (5).

By taking into account this sustainability, on the long run, it will save double of what they pay to operate the building. A study of the sustainable buildings proved that when we compare them to the general traditional buildings, we will find that the average consumption rate of electricity is less than 70 % and of water is less than 50 to 60 %, whereas energy is less than 3 %. Applying the principles of the sustainable buildings in the Kingdom of Saudi Arabia will save financial fund with 50 % which is estimated to be 100 billion Riyals of the total cost of the building, operating and maintaining the country projects, if we apply the principles of the sustainable architecture. The owner will also get an environment- friendly building that has heath quality in addition to its higher economic efficiency. We should also know that building in the traditional way and most of the available concrete and materials used in the building industry in the Kingdom of Saudi Arabia are bad and full of chemicals and gases which are not only harmful to the environment but also to the general health. We should also know that depending on the concrete materials in the building is not a fault in the material, but in the harms resulted by their faulty characteristics; including their great harms to the environment, especially their participation in the processes of the Global warming. This in addition to the fact that their costs became higher and stable, especially with the appearance of the instability of the cement, steel and building materials prices in the last few months. The building processes using the concrete materials became slow comparable to the modern techniques, in addition to higher cost of its wastes disposal. (6)

One of the most famous problems of the last period which decreased the chance to have projects and building that depend on the principles of the sustainability is the inability of the current planning techniques to meet the designer's needs to design their buildings with a sustainable way according to what the regulating lists contain of strict definition to a group of the land users and the likeability in defining the building sizes, heights and character. The huge financial availability and the lack of understanding the dimensions and results of the sustainable architecture led to some depression to the power of the interested market of that principle. Also, the inability of the urban regulating lists to impose the legislative power to reach the sustainable, human, attractive and beautiful environment, adding to that the role of the architectural designer in the last period was an individual role that seeks for the aesthetic forms of the building, searching for how to achieve that away from how to blend those aesthetic forms in the principles of the sustainable architecture. (5)

It is undoubtedly that this role lacks lots of positive points that the ideal way of thinking seeks to achieve the value of the sustainability. This study aims at studying, analyzing and evaluating the sustainability experiment in the Kingdom of Saudi Arabia through evaluating some buildings that have been established and designed in lots of sites in the Kingdom of Saudi Arabia; in a way that the buildings are analyzed from the descriptive side in addition to developing some specific standards through the building users. The users' opinions will be gathered through a questionnaire to explore the level of satisfaction of the experiment. Meetings with specialists, who designed the buildings and compared them before and after the design, will be held in order to know how to view the topic. All the factors and the terms used will be studied to come up with useful results, insha'a Allah, for the benefits of the decision makers and setting up strategies and a method for the sustainable building designs throughout the Kingdom of Saudi Arabia. (6)

2. The Research Problem:

The idea of techniques and the applications of sustainable buildings in the Kingdom of Saudi Arabia is a new idea if it is compared to other developed countries that took this approach in building for a long time of research, application, and philosophy because this method and due to several factors that we will mention later do not take enough attention neither in the scientific research nor in the scientific application. So, I decided to do this study in order to participate with those who already made this philosophy in building took its way to the interests of specialists largely and particularly, and the rest of society members in general as it is no longer a luxury or a contemporary way wanted to be established but it is an urgent need imposed by new economic, social, and environmental variables.

In addition to the above, the research studies that evaluate the satisfaction of users of these buildings with sustainable buildings are very low as it focuses its interest on the general global philosophical frame of this method of building. Its criteria without increase or decrease are subjected to the practical application. Therefore, I see that the environmental privacy in the Kingdom of Saudi Arabia imposes on us to give priority to some elements than others in terms of focus and importance, taking into account some of the environmental privacy that varies in the Kingdom of Saudi Arabia from other countries in the world.

There are several factors that hinder the practical application of this kind of buildings in the Kingdom of Saudi Arabia. They are also considered as obstacles that stand between this philosophy in building and between deployment and making it a necessary requirement that everyone believes in as a civilized contribution with the human effort in defending the environment and reducing the reasons that contribute in the environmental pollution threatening our small planet. The most important obstacles are:

2.1 Oil abundance: The abundance of oil and its cheap price in the Kingdom of Saudi Arabia made the use of it in all items of energy such as electricity and cars more easily than other alternatives of energy. Therefore, thinking of any other alternatives was ceased out of the wisdom that says "need is the mother of invention".

2.2 Customs and traditions: Customs and traditions in the Kingdom of Saudi Arabia represented in family and social relations are of the important factors that hinder the spread of buildings because of lack of awareness of society members with the importance of adhering to this kind of buildings, and not realizing what may be caused by the buildings that do not take into account the principles of sustainability in environmental pollution.

Thus, it is reflected on the health of the individuals and society as a whole.
Therefore, this study comes to measure and evaluate the willingness and satisfaction of users with the sustainable experiment through the experiments built on the grounds.

3. Objectives:

This study aims at studying, analyzing, and evaluating the buildings established in the Kingdom of Saudi Arabia which designed and implemented on the sustainable principle. Through this objective, there is a group of objectives which the study achieves:

3.1 Analytical study for a group of buildings depending on sustainability in the Kingdom of Saudi Arabia.
3.2 Studying of obstacles and determinants of applying the sustainability in the Kingdom of Saudi Arabia.
3.3 Putting some theoretical frames and applications for sustainability usages in the Kingdom of Saudi Arabia.
3.4 Adding the concept of user satisfaction as a main factor in designing the buildings established in the Kingdom of Saudi Arabia.

4. Climatic Topography of the Kingdom of Saudi Arabia:

Arab peninsula is located in the west south of Asia continent with an area of 3000000 km square. The Kingdom of Saudi Arabia occupies four-fifths of the area where it is bounded from north by Jordan and Iraq, from the east by the Gulf, from the west by the Red Sea, and from the South by the Arab Sea (the Indian Ocean). As for the political significance of the geographical location of the Arab Peninsula, it is quite clear as it contains the Grand Mosque in Mecca, and the prophet's mosque in Medina. For the strategic side, it is located between Asia and Africa continents, and it is very close to the Suez Canal. It has coastal borders on the Red Sea and the Arab Gulf. The oil wealth is existed in the eastern part of the island which gives it a more important position in the global economy. According to the movement and transfer of the Arab armor, it is increasingly declined and aroused in the west side parallel to the Red Sea and the eastern south of the Arab Peninsula, with a gradual decline from the east side of the Red Sea. The eastern side is covered by layers of small and sediment rocks. There are fields of lava with black color on the highlands which appear along the western side of the Peninsula, especially in the areas of Mecca and Medina (10).

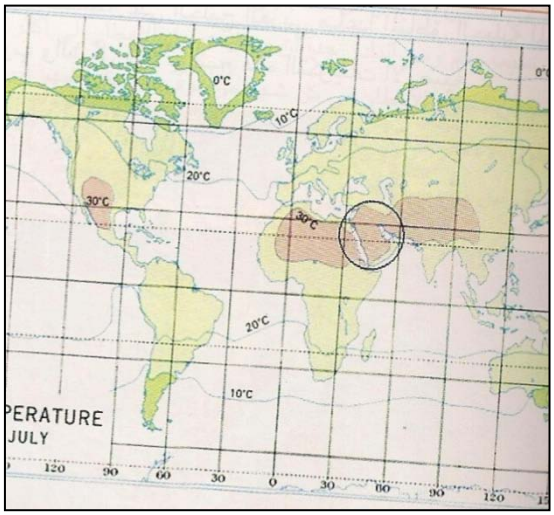

Figure1: The location of the Kingdom of Saudi Arabia form the world

In the western side, there is a coastal line along the Red Sea from the north to the South. It's width is increasing in the middle (Tohama), and direct to the east where formed high, broad, and high-rise plains overlooking the bottom of Tohama. Its highness is increasing in the western- south part of Saudi and Yemen as it reaches to more than 3100 meters (10000 feet). The highness decreases gradually towards the east. The area of Empty Quarter “Rub' al Khali” is located in the south, which is a large sandy area with an area of 250000 square meters. These plains end from the eastern side with low coastal areas on the Arab Gulf except the high mountain regions in Oman from east and south. (10)
The Arab Peninsula is one of the most dry area in the world, and its weather is mainly influenced from the north and west sides. The climate of Arab Peninsula is linked to the climate of east Mediterranean Sea and neighbor areas. It is characterized by hot, dry, and long summer in the central areas, hot and humid in the coastal areas with short and cold winter percolated by short rainfalls except in the high areas of Yemen, Asir, and Oman because the air masses that reach to the east and middle of the island draining all its moisture. Although the Arab Peninsula is surrounded by water bodies from three sides, but the drought (lack of rain) is a dominant factor with the exception of highlands in the far south and west south. (11)

Figure2: Topography of the Kingdom of Saudi Arabia

The first climatic character that characterizes the climate of the Arab Peninsula is the lack of annual rainfall and often rainfall which rains each time is about 2.5 mm and a rate of fifteen percent of rainfall from three to five mm only by about ten percent is raining from five to seven. It is very rare to the rainfall to reach more than this. Although the rainfall in the month of November until April, the Arab Peninsula is characterized by rainfall at the beginning of spring when the plants need moisture, and at the end of season before the start of the drought season in summer. It is known that dry air temperature non loaded with clouds to the center of the Arab Peninsula that leads to great highness in temperatures that may reach 50 degree Celsius (122 Fahrenheit) in the shade. Sometimes it exceeds this in some areas, and the lack of clouds allows the temperature to leak into the sky at night, especially in winter the temperature decreases remarkably at night. The temperatures vary between day and night from 10 degree Celsius to 22 (35 Fahrenheit to 65 Fahrenheit)

and unbearable daytime temperatures in the summer is followed by cold temperatures, and freezes frequently in the desert and north regions during winter. (12).

Region	Maximum	Minimum
Northern region	110 Mm	50 Mm
The coastal region Western and Eastern	90 Mm	70 Mm
Desert region	125 Mm	40 Mm
Highlands	320 Mm	180 Mm

Table1: Average annual rainfall

From climatic characteristics that distinguish this region on the high levels of solar radiation. These are massive amounts of unexploited natural energy as huge amounts of solar energy falls on earth, but we rely on a very small rate in our life, and an amount of solar energy that reaches the top of the atmosphere is estimated with 4672 British unit/ hour/square meter (4672 Btu/hr/m2) i.e. 1160 kilo calorie per hour per square meter (1160kcal/hr/m2). But part of this radiation is reflected into the space, and part is absorbed in the atmosphere by air atoms, dust particles, and clouds. What is remained from the radiation is about 50% falling on the earth surface. The falling solar energy amount differs from region to another; rate in the middle desert regions is the highest. It also relies on day hours, width line, season, and weather. We also can benefit from the sun radiation even in shaded areas, as the sun radiations fall on the earth with different lengths and waves, ranging among x-rays, ultraviolet, and infrared…etc. But a large proportion of this energy which is usable is visible light waves or short waves. Whenever there is natural light, there will be the solar energy. We can measure the energy amount from sunlight falling on any surface such as windows, gardens or energy collection panels…etc. These information is available in the references of ASHRAE association (American Engineers Society for Heating, Cooling, and Air Conditioning), and other sources for measuring the projection angels on the surfaces of different wide lines, different day times, elevation angels, different deviation angels, all wide and length lines, and year seasons. From this information, we can calculate the size and shape of the assembly tools and the surfaces of sunlight collection (12).

Region	Winter (December, January, February)		Summer (June, July, August)	
	maximum	minimum	maximum	minimum
Northern region	15 ° C	-3 ° C	38 ° C	23 ° C
The Western coastal region	28 ° C	18 ° C	39 ° C	27 ° C
Desert region	10 ° C	06 ° C	43 ° C	30 ° C
The Eastern coastal region	22 ° C	10 ° C	43 ° C	30 ° C
The upland areas of mountain	19 ° C	06 ° C	31 ° C	13 ° C

Table2: Average temperature (maximum, minimum)

As for the wind of the Arab peninsula, it blows in general from north or west north or west. In the western coastal areas, the wind comes from northwest and west. In the central desert, the wind comes from north and northeast. In the north regions, the wind comes from the west. In the southwest and southeast areas, the wind comes from west, southwest, and east. The temperatures near to the ground level in the desert weaves hundreds of times a day and ranges between 35 degrees Celsius to 60 degrees Celsius (95 Fahrenheit to 140 Fahrenheit) when the sunlight and heat are re-radiated from the earth, and even in winter, the weave ranges between 10 degrees Celsius to 45 degrees Celsius (50 Fahrenheit to 113 Fahrenheit). The hot air is raised, and the cold air replaced it. Whenever the temperature is increased, the movement is increased, so the vertical wind is blowing in the desert as a result. (13).

Hot windstorms have enormous evaporative force which is capable of doing large damages to nature and often carry sand grains that scratch glass, impede the mechanical devices, and accumulate on the devices surfaces and on the desert ways quickly. In sometimes of the year and in some regions, the wind and sandstorms blow for several days and it is sometimes possible to confront them. Sandstorms blow often in spring and when the weather conditions are suitable. In the east coasts, for instances 60% of June, sandstorms blow. (13)

5. Description of Sustainable Building in Saudi Arabia:

5.1 Salam Park:

Salam Park is considered to be a green lung that gives breath to the Riyadh districts. It is one of the most important natural sources of the centre of the Riyadh City which is represented in the region of Al Hakim Palace (the heart of the city of Riyadh and its historical and heritage) that witnessed the launch of the establishment of the modern Kingdom of Saudi Arabia which includes the Mosque of Al Imam Turkey Bin Abd Allah, Al Hakam Palace and Al Musmak Fort, in addition to its being as a trading centre. By the time the Salam Park opened its gate for the crowd, lots of visitors came to visit which is considered to be two issues in the country matters and their populations:

First: it became one of the urban regions that digest all the social interactivity requirements, the communication and achieving some of the basic requirements and needs that are not available in the city residences.

Second: the residents' need for the open areas, and their awareness of the benefits that have become available because of the Salam Park that has offered all the social and service requirements. (14)

Figure3: Ground Floor Plane

By the time His Royal Highness; the Prince Salman Bin Abdel Aziz, the President of the Higher Authority for the Development of Riyadh City opened the Salam park on the 14th of Zul Qaida' 1424 H. The Park was designed by the Higher Authority for the Development of Riyadh City, and it was designed in 1996 and its construction finished in 1999. It is located paralleled to the region of Al Hakim Palace in the Southern direction, and it is bounded by the King Fahd Road from the west, and Tarik Bin Zeyad Street from the North, and Asir Street from the South. Its space is 12 thousand square kilometer. The park is equipped with a car parking lot that digests 350 cars, in addition to five main entrances and locations for the water closets.

The location site of the Salam Park was a famous old farm carried the same title. It was famous for its quality of the Palm. It was named "Bel Mahrak" after it has been burned because of one of the wars. Then the Prince Abd Allah Bin Abd El Rahman owned it and increased the number of its palm. Lots of market had been established in the past. The farm – when expropriation – was keeping some of its high quality palm, in addition to a small Masjid built by the Prince Abd Allah Bin Abd El Rahman in 1939. It was one of the concrete buildings in the City of Riyadh – its Imam was the Sheikh Abd Allah Bin Abd El Rahman Bin Hamdan. During the urbanization of the city of Riyadh, the location site of the Salam park has become remarkable, after it had been on the margins of the inhabitants, it became in the Centre of the City of Riyadh, it looks at the most important main roads in the City of Riyadh, as it lies on the south- eastern side of the intersection of King Fahd Road with Tarik Bin Zeyad Street, in an inhabitant area remarked by its over population and its close to the site of Al Hakam Palace. (15)

The main idea of the design of the Salam project is based on how to get benefit from the site features, whether from its large space, or from its remarkable location in setting up a general facility all over the city to serve all its districts and inhabitants. This site is a landmark and a source of tourism industry in the City. In addition to taking care of the requirements of the surrounding neighborhoods which suffer from the lack of open areas, and above all taking care of the requirements of the strategic planning or development of the downtown area, and their role toward all over the city. So, the idea was to find a natural, green, highly equipped, open and related area that has lots of different environmental patterns that have the ability to digest promotional, cultural, varied and renewable activities all over the year and available most of the time. By doing this, this facility achieves benefit to all the city inhabitants and visitors, by considering the park – together with its space and the variety of its remarkable area – in a remarkable middle location. The variety of the environments contributes to the ability to achieve satisfaction of all visitors; this variety of the large and wide spaces provides them with the freedom to choose between the activities and to feel more specialized comparable to what the other public parks offer.

Salam Park offers large spaces of open areas, which are different in their structure, preparing and what they offer to the visitors of the promotional and cultural activities. These different activities that are available in the park location spring from the topographic nature of the park land, and what it contains of elements. The farm environment contained all the remnants of the old Salam Park with all new additions, the hills environments were composed of the soil that came out of the lake drillings. The Park is composed of the following four different environments and areas. (14)

5.1.1 The farm environment.
5.1.2 The hills environments.
5.1.3 The lake environments
5.1.4 The environmental region.

5.1.1 The farm environment: this part is located in the northern side of the Park. It has all what remains of the Salam fruitful palm with all the new additions. Due to the high quality of the remnant palm; new palm have been added, so the total number of the Park palm in the farm region reached 1250 palms. This area is remarkable for not having specifications from any kind for the crowd with the exception of the palm and their shadow. In this way, it gives visitors a chance to choose a place to sit without any imposed restrictions. The region atmosphere initiates the remembrance of the old classical farms, and the palm groves that enclosed the City of Riyadh in the past. Due to the height of the palm, the nature of its structure and its remarkable density in the Park; the farm area is characterized by having lots of shadow during most times of the day. This area is also remarkable for offering lots of playgrounds for the children with their modern equipments with the exception of the light environments to save the natural atmosphere as being the sample of the traditional farms. (15)

Figure4: The farm environment

5.1.2 The hills environments: the hill environment controls the centre of the Park – approximately – the topographic components were resulted by the drilling works of the lake, which formed a group of separated hills that their height is not more than 6 meters, they are remarkable for their simple slide that makes them safe for all the visitors of all ages to walk over. The hills environment is penetrated by some pedestrians' footpaths and the children playgrounds that simplify controlling them from the upper heights of the hills. The area is also covered with palm and the lighting columns are established (15).

Figure5: The hills environments

5.1.3 The lake environment: it is located in the southern side of the Park. Its space reaches 34.000 square meters. It takes more than 110.000 cubic meters. This flat area with its large space is considered to be an attracting point for the Park visitors. At the same time; it performs a number of complementary functions for the other factors of the Park. Its establishment necessitates a huge number of the basic necessary requirements; as the lake, with its large space, is considered to be a basic effect in the Park climate from increasing the moisture level to tempering the temperature. Some of its extended enclaves in the south eastern side of the Park are considered to be a part of the environmental region that contains various kinds of the fungi, plant and animal organisms. (14)

Figure6: The lake environment

5.1.4 The environmental region: it is located in the south eastern side of the Park. It gets benefit – in its structure- from a small area of the low hills, green flats and other extended enclaves from the lake. It constructs a natural environment for some different kinds of the wildlife. Due to the sensitivity of the wildlife, and the need to a special care; the crowd are going to be able to get benefit of this region under the control and the guidance of the Park rangers. In addition to the environmental variety that the Park contains; as it contains some of the remarkable prominent elements that contribute to its remarkable position and its ability to compete with all the other promotional regions in the regions of the City of Riyadh. The Park facilities include the following (15).

5.2.1 The footpaths. 5.2.2 The playgrounds.
5.2.3 The public general facilities.

Figure7: The environmental region

5.2.1 The footpaths: the Salam Park is composed from a green flat area and water surfaces. As the sport of walking around and joggling in that natural environment are considered to be main asserted desires for the visitors, the park is equipped with different patterns of the footpaths for the pedestrians. These footpaths perform two functions, the first is controlling the visitors' condensed movements away from the green flat areas that are damaged because of the dense walk. These footpaths perform the roles of the guide to the exploration walking of the Park elements. The Park includes four kinds of footpaths for the pedestrians; all of them are available to all the age groups, and people of special needs. They are like the following (14).

5.2.1.1 The service footpaths.
5.2.1.2 The internal footpaths.
5.2.1.3 Pedestrians footpaths.

5.2.2 The playgrounds: the Park has playgrounds in addition to promotional activities that are not available in any other open areas in the City of Riyadh. The water games are at the top of the activities in the park, because the flat surface of the lake makes it easy to get benefit of different kinds of water games, on the rowing boats, pedal boats, remote- sensing boats, in addition to the children playgrounds, which are considered to be flat sandy areas that contain movement games for the children. These playgrounds are remarkable for their uncovered locations that make it easy for the crowd to control them from remote places. They are also remarkable for its spread throughout the park. There are also the footpaths for the horse riding, the cycling, skiing and the remote sensing cars. (15)

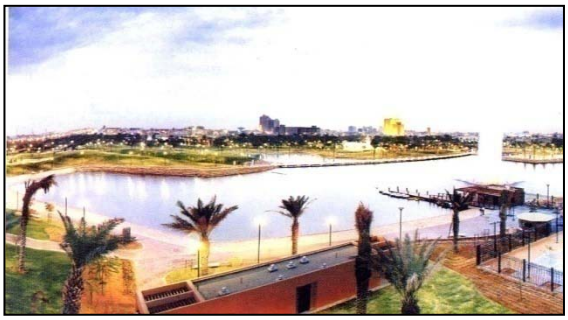

Figure8: The playgrounds

5.2.2 The public facilities: on their top come the mosques and the small paces for praying. The park has two mosques; the first is in its middle area; it is considered to be a historic mosque that goes back to 60 years ago. This mosque was rebuilt and equipped with the necessary equipment in addition to the outside mosque that is paralleled to the Park from the eastern side. The Park also has some small places for praying; distributed throughout the Park. In the near future, the park will be equipped with a restaurant that has a view on the lake, a floating restaurant and there is also a main coffee shop. The Park also has a small zoo that includes bird garden, reptiles' cave, a protective area and an area special for the butterflies. The green flat areas in the park as well as the service facilities are in need for a permanent water source. The authority plan to reuse the water, reduce the sources and blend the infrastructure facilities includes linking the Salam Park to a system to reduce the level of the sewage water along the King

Fahd Road. This system is composed of 1000 surface wells spread along the road tunnels to drain the surface water through a ground grid to a treatment plant near Al Shomeissi tunnel where it is treated through two treating plants working with the system of the solar reflexive in the Park, before being ready to compensate the wasting water from the lake surfaces, and the irrigation of the different facilities. This water is used in irrigating the plants, compensating the lake water, the public cleaning works; whereas the drinking water has another independent source. (15)

Figure9: The public facilities

5.2 The Al Tawuniya Tower

This building is located in the City of Riyadh. It is founded on the King Fahd Road in the North side of Riyadh City on an area (120 m × 60 m). This project costs about 239 Million Riyals. It has been executed in 24 months. The Cooperative Company for insurance is considered to be a main rent body in that Tower. This building is composed of two opposite towers with 17th floor specialized to office areas reach to (34.000 square meters) over three floors from the horizontal basis. There are trading center, public spaces, shaded galleries and roof garden. There are also three floors to safe the car parking lots for all the offices, whereas from the technical side, this project uses Thermal Energy storage (TES) system; which is considered to be a system that depends on operating the coolers at night and storing the cold, icy water to be used during the day which helps to reduce the electrical power consumption during the hours of the summer days, and reduces the number of the coolers with 25 %, also reduces the general electrical power consumption with 15 % approximately. Its designer adopted the contrastive principle as a philosophical method for designing it. He got firmly hold of the principle and traced it throughout the design aspects and some other architectural elements. What may be easily shown from the principle is its contradiction in the engineering structure between the rectangle that represents the horizontal basis and the triangle represented by two opposite triangular towers over it. This is highly related to the power of the architectural design terms that he adopted and applied. (16)

While we see the rectangular basis as independent and strictly parallel, some traditional footprints in treating the roof tops of the horizontal and vertical surfaces and treating them with the columns, and we find the two towers appearing in a strict and strong way among three rows of the palm trees that are extended in front of the King Fahd Road in a form that contains an open (plaza) in front of the building to stress the contrastive principle between the acute angles and the flat roofs, and among the transparent glass and the cast granite (as outlined in the next figures). We also find that the tower part of the building (the office areas) is divided into two triangles attached from the basis and they are separated with a huge canal that takes over all the height of the building, which stresses the contrastive principle between the opposite north and south (as outlined in the next figure).

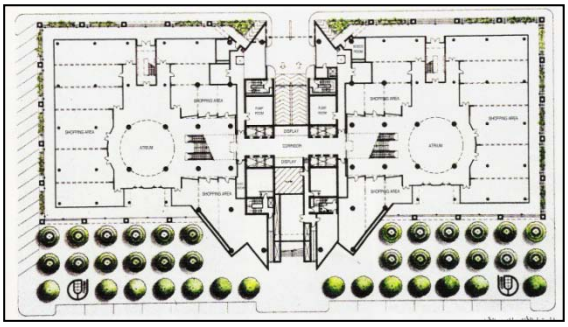

Figure10: Ground Floor Plane.

There is also another contrastive pattern that is represented in the transparency and the softness of the blue glass cover that coats the two northern and southern facades (partially reflective glass) for the privacy and harshness of the curtains that cover them from the outside surface which is made from the concrete covered with the bluish color and the grayish background (it is treated using the fire to the harshness of the surface).

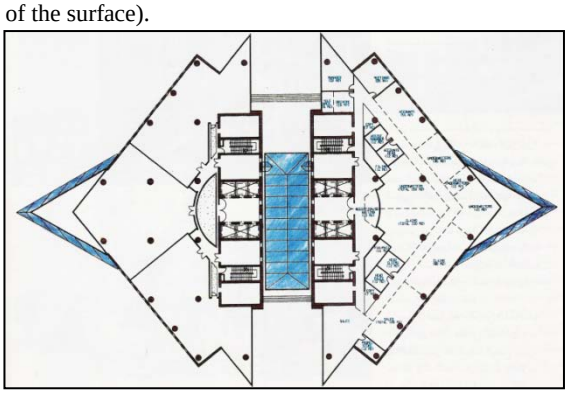

Figure11: Repetition Floor.

It may also be considered that using the materials of those two elements is a stress on the contrastive principle between the resulted effects on the glass as a reflective mirror, and between the granite curtains as a traditional Mashrabia in addition to its resistance to the environmental elements that affect the city. These principles are applied in treating the architectural elements and details inside the building.

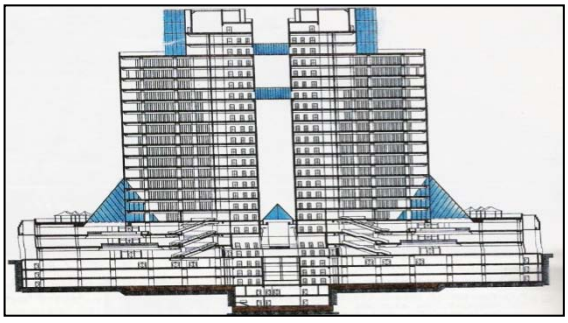

Figure12: Section

The designer also takes care of giving a glance of the viewers to see those optical effects during walking around the trading centre in the first ground floors, or taking a quick glance for the other side of the pyramid tower, or the higher triangular lightings along the two sides of the two towers, through what they offer through the fallings and the sectors from the architectural characteristics that help to keep and maintain the visual relationship for the visitor and the building with its different parts by the color and the touch. (16)

Figure13: Perspective of the project

5.3 Toweek Palace:

The Higher Authority for the Development of Riyadh City designed and supervised the establishment phases of that project. The space of the palace is 77000 square meters, the total space for the building is 24000 square meters, and the space of the internal garden is 10000 square meters, whereas the space of the Palace is 520 square meters. The project total cost is 117 million Riyals. It was designed by the House of Urban Studies- Kingdom of Saudi Arabia, the Free- auto for architecture of the Western Germany, and Peru Hapold for Engineering of the United Kingdom. (16)

Figure14: Toweek Palace.

This palace was designed in the form of a huge populated wall taking the shape of Cobra that represents the main building of the palace and it rotates around the entire garden to protect it from the wind or any other natural factors. The Palace with its huge wall made of the rocks of Riyadh is in complete harmony with its surrounding desert nature. This site; from its location above the rocky hill; looks like a spring. It is very modern in its use of the system of the organic architecture. The external tents with their white color are in harmony through their differentiation in both the color and the touch, which shows the intimate relationship between the tent and the desert.

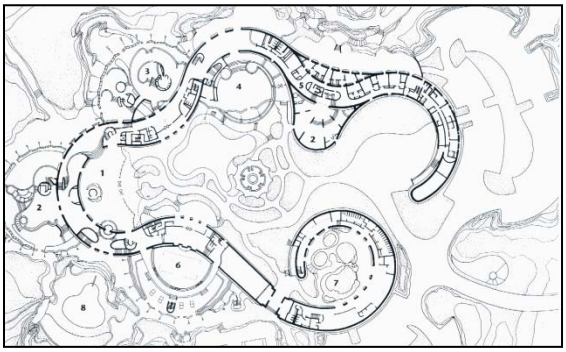

Figure15: Ground Floor Plane.

Also the similarity between the wall openings with their arch shape which looks like spontaneous. Once you get close to the spaces covered with tents, you can see the inside nature of the tents, then you can move forward to the valley… (16)

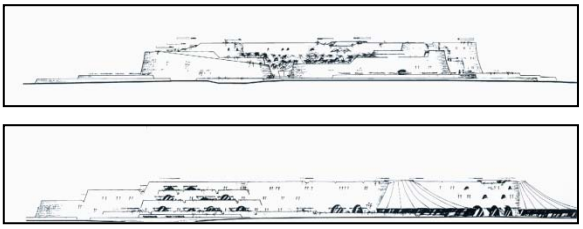

Figure16: Sections.

One of the main reasons behind awarding the Agha Khan Prize is that the palace is a successful example in blending the traditional architectural expressions with the local materials through the use of developed materials and techniques without falling in the point of weakness of the discrepancies between the modern and the known traditional standards. Marble and Riyadh Rocks were used in building this palace from inside and outside. The palace is composed of a huge wall with length 800 meters, height 12 meters, and thickness between 7 to 13 meters. This wall is made from concrete with thickness 30 cm and it was covered from the outside with an insulated material. So this wall has a special characteristic which is protecting the Palace elements from the strong heat during the day and it can absorb the cold air of the night for longer periods of time. The wall of the palace circulates an internal fruitful garden which is very rich in its famous and the flowery ornamental plants which help to offer a suitable atmosphere among the palm trees and the waterfalls. A tent with 7 meter height is in the middle of this garden; it includes seating places and water pond. This tent was made from the steel; its ceiling which is covered with glass board is raised over steel carrier with three pillars. It was supported with a steel column with 7.3 meter height in the middle of the tent. There is also a multipurpose hall under the tent; this hall looks towards the internal garden and it is linked to the other internal elements of the Palace. This hall is equipped with

developed audio- video equipment. There are three harmonious white tents on the wall of the Palace from the outside; they cover multi-purposes halls each of which is 1600 square meters space and they are linked to the internal elements of the palace. One of these halls looks towards the north eastern side of Hanifa Valley; it is composed of many levels and there is a water flat surface in its centre. The second hall looks towards the northern side of the valley and it is linked to the main kitchen which is linked also to three sitting rooms. But the third hall looks towards the western side of the valley, where there is a sport suite that contains a bowling pitch, squash courts, steam baths, massage rooms and other rooms for the general supported services. Inside the wall that constitutes the Hosting Palace there is a hosting house on three levels. This building is composed of four suites and 25 rooms all of which look toward the valley. Including in the wall, there is also a lecture room that can take 200 seats. The palace is encircled with a desert garden where you can only find the desert plants and trees. The functional program of the Toweek palace makes it easy for lots of services to be offered for the City of Riyadh. The program includes lots of official social and cultural events; where it can digest the official occasions and festivals in addition to the displaying fairs of the great international, cultural, trading and commercial companies in addition to the scientific symposia … etc. (17)

Figure17: Perspectives of the project.

5.4 The King Abd El Aziz Public Library:

This public library is located in the centre of the City of Riyadh; it is located in the south of the historical Centre of Abdel Aziz. King Saud Street goes through the Historical Centre form the centre, it is bounded to the east by the Minister Street, and to the west by the Street of Mosa'ed Bin Halwa. The centre is also near to King Fahd Road which makes it easy to access and get.

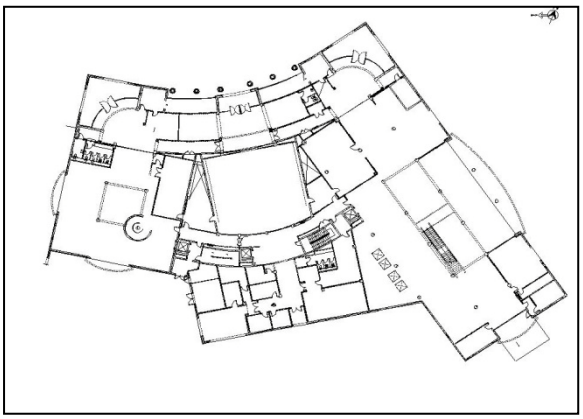

Figure18: Ground Floor Plane.

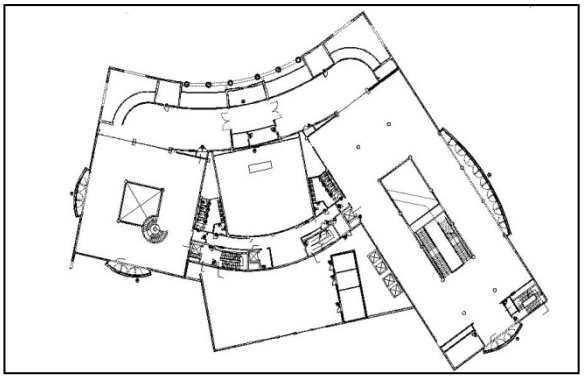

Figure19: First Floor Plane.

The building façade looks toward the north eastern direction in order to be in harmony with the neighborhood building which its façade looks toward the north western direction which looks like that the two buildings welcome their guests. The building was directed to the direction in order to look toward the main square, in front of the library, there are lots of garden ornamented areas and equipped with pedestrians' footpaths surrounded by lights and trees, whereas in the back you find the car parking lots for the employees and the library visitors. This building with its simple shape that is in harmony with the surrounding beautiful spaces is harmonious; but the simplicity of the shape does not describe the simplicity of the content. This building contains multi facilities for different procedures.

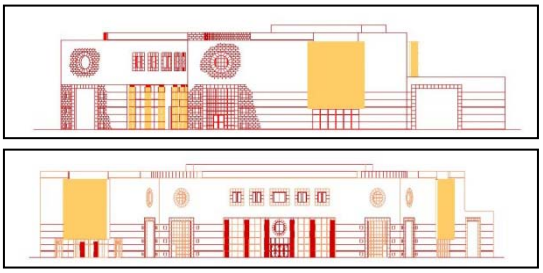

Figure20: Sections

The library is composed of three sections which are the women section, the children section and the men section. The children section lies in the basement and it includes lots of activities that aim at educating the child and culturing him. But the men and the women sections lie in the ground and the first floor. The men section lies to the right side of the building, whereas the women section lies to the other side; they have the same distribution, because the ground floor is composed of the entrance, the reception and the Book hall which is centered by a huge large foyer reaches to the second floor of the building. The first thing to attract the visitor when entering the library is the bridges and the hanged footpaths that link the components of the first and the second floor as if there is an architectural drama work. In the centre of the book hall, there are stairs that link all the library floors. In the first floor, there is also a book hall and a section for information and internet. (17)

Figure21: Predatory sun used.

The administration section is in the second floor. The walls of the reading halls were covered with glass for the reader to enjoy seeing the gardens and the green areas surrounding the library, in the way that he can be linked to the outside environment which makes him feel relaxed. The necessary natural lights are also offered. We notice in the design that there is good distribution for the spaces and they are greatly linked and easily accessed, we also find the good arrangements for the book drawers when the person stands in the centre of the hall, he can see all of the hall easily. Because the nature of the City of Riyadh is characterized by being as hot in the summer, but warm and rainy in the winter, so the designer has to take care of that. This is what we see in the design of the library through his use of the colors suitable to the sun rays as it cannot store a huge quantity of the sun rays and the designer uses some heat non conductive materials and these materials are reflecting the sun rays. The Mashrabias are out in a modern style that is in harmony with the modernity of the building and according to the designing method that gathers both the traditional ways with the modern ones. It is also noticeable in the pictures that these Mashrabias are made from rust- resistant stainless steel. The windows of the facades were treated and holes and openings in the western side were also treated to avoid the excessive heat and the ceiling was also treated with heat reflexive glass to offer the desired level of lighting. It is also noticeable that there is a bump in the internal

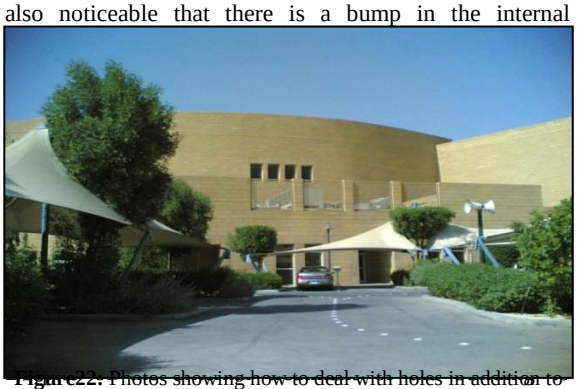

Figure22: Photos showing how to deal with holes in addition to the materials used

overcome the sun heat, there cannot be any neglect to the artificial air condition units inside the building and the lack of windows in the footpaths. This is in no doubt increase the total consumption cost of the building. The reading seats were directed toward the north in order to avoid the sun and heat coming from the west of the building.

Wind speed is considered an important element affecting the feel of thermal comfort and it has its importance in guiding the building and design. Thus, we notice the concern of the designer with the wind through the bending of the building facades interiorly, together with the expansion of the building exterior areas that are considered as air distributor and motivator to the entry of the building and windows located amid the bending. Also wind was not uniquely exploited for the ventilation of the building from the inside. Moreover, no procedure was taken regarding rains and moisture management. This is due to its non importance in the desert dry location as we have mentioned in the subject of heat except in the usage of insulating materials that prevent water penetration. The building may be subjected to problems in case of rainfalls because the external pathways were not handled and remained as it is, the matter that subjects it to the absorption of water and formation of Swamps. The designer was successful in solving the problem of dust by using the suitable colors from one part and minimizing windows openings from other part. The number of windows in the parts that winds carry dust is now minimized. Yards were made in a suitable color in order to avoid cleaning these yards for many times. Materials for covering walls were used in away maintaining the less absorption of heat temperature and its storage. Suitable constructional materials were used to insulate buildings from the external environment. Of these methods (17):

5.4.1 Making the external surfaces with projection in order to reduce the heat storage.

5.4.2 Using insulting materials preventing the water penetration inside the building.

5.4.3 Using colors reflecting a large portion of sun beams.

5.4.4 As for the openings, it was coated with glass that reduces the sun beams penetrating the building.

Figure23: Perspectives of the project

The project name	The project area	The design idea	The owner\ designer	The environmental treatment used	Notes
AlTawuniya tower		Its designer adopted the contrastive principle as a philosophical method for designing it. He got firmly hold of the principle and traced it throughout the design aspects and some other architectural elements. What may be easily shown from the principle is its contradiction in the engineering structure between the rectangle that represents the horizontal basis and the triangle represented by two opposite triangular towers over it. This is highly related to the power of the architectural design terms that he adopted and applied.	The owner: the cooperative company for architectural investment The designer: the house of Urban studies	Thermal Energy storage (TES) has been used for cooling. This system depends on operating the coolers over the nights and storing the cold or icy water to be used during the day; in a way that reduces the electric power used during the hours of the day in the Summer season, and also reduces the number of the coolers with 25 %, in addition to reducing the general electric consumption rate with 15 % respectively.	
Toweek Palace	24000m2	This palace was designed in the form of a huge populated wall takes the shape of Cobra that represents the main building of the palace and it rotates around the entire garden to protect it from the wind or any other natural factors.	The house of Urban studies Kingdom of Saudi Arabia. Free- auto for architecture- the western Germany. Peru- Hapold Engineering- the United Kingdom	This design reflects the best way to deal with the site and total apprehension of its natural characteristics, as the palace with its huge wall which was built from the Riyadh rocks is in complete harmony with its surrounding desert nature. This site; from its location above the rocky hill; looks like a spring. It is very modern in its use of the system of the organic architecture	Has been awarded the International Agha-Khan Prize
King Abd El Aziz Public Library		It is designed to be an urban heart beats in culture in the Riyadh downtown. On the other hand the designer considered it as a promotional oasis that simplifies the daily routine and rhythm of the city.	The owner and the general supervisor: the Higher authority for the city of Riyadh development	1- Its use of the suitable color of the sun rays, as it doesn't store a huge amount of the sun rays. 2- The designer takes care of the wind power through bending the building facades to the inside and the wideness of the outside areas. The designer achieved success in solving the problem of the dust through his use of the appropriate color from one side, and minimizing the window openings form the other side.	
Toweek Palace	312000 m^2	Offering a natural, highly equipped and open region. It is characterized by having different kinds of environments that have the ability to absorb some promotional, cultural and different activities; these activities are varied along the year, and available throughout the time periods of the year.	The owner and the general supervisor: the Higher authority for the city of Riyadh development	1- Using the water elements to increase the cooling degree and tempering the temperature. 2- The green flat areas in the park; in addition to the service facilities are in need for a permanent source for water. As the organization works to reuse the water, reduce the sources, and to blend the projects of the infra- structural facilities, the Salam Park was equipped with a system of reducing the sewage water level along the road of the King Fahd. This system was composed of one thousand surface wells that were spread along the road tunnels. These wells drag the surface water through a ground grid to treatment plants near the "Shumeissi" tunnel; to be treated by using two treatment Plants powered by the system of reflexive contradiction in the Park before being ready, in order to compensate the lost water from the flats of the lake, irrigate the different facilities of the park. This water is only used in the purposes of irrigating the plants; compensate the lake water, the general clean service works; whereas the drinking water has another independent source.	

Table3: Comparison between the projects.

6. Findings and conclusions:

Through the study that was made on the targeted sample selected according to its living for the buildings designed on the sustainable principle that have been explained and detailed in advance, we find that there is unawareness with sustainability concept, and indifference of the environment impact by the pollutants resulting from buildings as 33% of users agree on the sustainability principles application, and observing the climatic change as a result of negligence in applying sustainability principles. The reason of lack of interest of Saudi society to apply sustainability concept and practice is due to petroleum abundance, increasing financial liquidity of persons, and unwillingness of the Saudi investors in increasing money in stages of design and instruction to apply sustainability principles (23).

With their ignorance that sustainable buildings will provide them in the long run double the amount that they will pay in the stages of maintenance and operation of the building through personal meetings that have made with the officials, besides real estate investment traders see that the applications of sustainability principle is wasting money and not serving their personal interests. Throughout the studies conducted on the targeted projects, it became clear that there is a weakness in the utmost exploitation of resources and energies of the Kingdom of Saudi Arabia, the most important of which are sun and wind that can be largely and effectively made use of than the one used currently. (21) Moreover, the users are not satisfied with the elements that abstain the sun beams from them like curtains, sun breakers, and other elements. Many of the sample participants, who are about 39%, expressed their dissatisfaction with the sun breakers used generally in the Kingdom, together with their full reliance on the mechanic air conditioning and facilitation of their life. It is known that the Kingdom of Saudi Arabia is suffering from the decrease of water and it is considered the rarest place in the world due to its climatic nature in the kingdom and the increase of heat temperature largely up to 50 C. For knowledge, the water that the city of Riyadh feeds from is coming from the Arabian Gulf water which is far about 400 Km in distance. This is in addition to the imaginary sums of money that the government spends in order to make desalination of the Arabian Gulf water and shipping it to the city of Riyadh (the capital of KSA). The research also found that some participants who answered through the distributed questionnaire that they are satisfied with those who deal with water as a renewable source can't be run out. (22) They are about 45%. Thus, sustainability is an idea and approach with an effective power whose achievement is not simple and easy. The challenge lies in the modification of our ways of living and our economic and social methods (19).

In the following, there is an analysis of the results of the distributed questionnaire in which we can see that the questionnaire is centered on four axes. They are:

6.1 Users' satisfaction with the applications of natural energies usage (20).

6.2 Users' satisfaction with the applications of water resource conservation methods either inside or outside building.

6.3 Users' satisfaction with the lightening used currently.

6.4 Users' satisfaction with the methods of color usages in the building facades.

6.1 Model about satisfaction on natural energies:

The questions measuring the extent of users' satisfaction with the applications using the natural energies include the following:

6.1.1 What is the level of your satisfaction with the usage of the mechanic means in conditioning the buildings generally with our ability of replacing it by environmental means? (**SME**).

6.1.2 What is the level of your satisfaction with curtains that reduce the sun heat in the summer within the buildings generally? (**SBL**).

6.1.3 What is the level of your satisfaction with using bays and sun breakers that break the sun beams and let the air passes through the buildings generally? (**SSD**).

6.1.4 What is the level of your satisfaction with the ventilation level inside the buildings generally? (SVT)

6.1.5 What is the level of your satisfaction with the usage of renewable energy sources (wind, sun) in the buildings generally? (**SREG**).

6.1.6 What is the level of your satisfaction with the thermal insulators used in the buildings generally? (**SINS**).

The Result Model is:

SKSU = 1.726 + (0.145 * SME) + (0.00529 * SBL) + (0.0219 * SSD) + (0.0407 * SVT) - (0.121 * SREG) + (0.0761 * SINS)

N = 80

R = 0.229 Rsqr = 0.0524 Adj Rsqr = 0.000

Standard Error of Estimate = 0.946

Constant	Coefficient	Std.Err	t	P	VIF
SME	0.145	0.104	1.390	0.169	1.178
SBL	0.00529	0.141	0.037	0.970	1.326
SSD	0.0219	0.113	0.193	0.847	1.260
SVT	0.0407	0.106	0.384	0.702	1.090
SREG	-0.121	0.120	-1.008	0.317	1.139
SINS	0.0761	0.133	0.571	0.570	1.310

Table4: Comparison between the elements of user satisfaction wiht the natural energies used (25).

Analysis of Variance:

	DF	SS	MS	F	P
Regression	6	3.613	0.602	0.673	0.671
Residual	73	65.274	0.894		
Total	79	68.888	0.872		

Table5: Analysis of variance between the extent of user satisfaction with the natural energies used (25).

Through the results appeared to us, we found an inclination of a large section of the sample towards satisfaction with the usage of the mechanic means and getting along without the natural ventilation sources. We can see that they are not totally satisfied with the bays and breakers used to abstain the sun beams from them. As for the rest of the sample, they are neutral.

Methods of water conservation

The questions measuring the extent of users' satisfaction.

6.2 Model about satisfaction of The Methods of maintaining water inside the building:

The applications of water conservation methods include the following:

6.2.1 What is the level of your satisfaction with some people who deals with water as if it is an unlimited resource? (**SWT**)
6.2.2 What is the level of your satisfaction with the re-usage of semi clean water that will have the effect on reducing water consumption in building generally? (**SRCY**).
6.2.3 What is the level of your satisfaction with the building techniques used to reduced water wasting occurring from faucets and saline flush tanks in toilets generally? (SWS).

The Result Model is:

SKSU = 1.809 + (0.0592 * SWT) + (0.0725 * SRCY) - (0.00204 * SWS)

N = 80

R = 0.0958 Rsqr = 0.00917 Adj Rsqr=0.000

Standard Error of Estimate = 0.948

Constant	Coefficient	Std.Err	t	P	VIF
Constant	1.809	0.500	3.618	<0.001	
SWT	0.0592	0.114	0.519	0.605	1.001
SRCY	0.0725	0.112	0.647	0.520	1.001

Table6: Comparison between the elements of user satisfaction with the methods of maintaining water inside the building (25).

Analysis of Variance:

	DF	SS	MS	F	P
Regression	3	0.632	0.211	0.235	0.872
Residual	76	68.255	0.898		
Total	79	68.888	0.872		

Table7: Analysis of variance between the extent of user satisfaction for the Methods of maintaining water inside the building (25).

Through the results, they are satisfied and accepting the idea of reusing semi clean water that will have the good impact on reducing water consumption. But we found that they are not interested in the modern methods that reduce the usage and consumption of water which are used in faucets and flush tanks in toilets. As for the methods and means of water usage and dealing with it as an unlimited resource, we found them neutral in this regard.

6.3 Model about satisfaction of Lightening and building:

The questions measuring the extent of users' satisfaction with the applications lightening and the method of dealing with it in the building include:

6.3.1 What is the level of your satisfaction with the windows distribution in the space you are working in? (**SLGT**).
6.3.2 What is the level of your satisfaction with the interior yards in the buildings? (**SWND**).
6.3.3 What is the level of your satisfaction with the necessity of caring for the building heights and distances in the site planning in order not to let a building abstain light from the other? (**SCRT**).
6.3.4 What is the level of your satisfaction with the direction of the building you are working in? Did it care for the climate effects in direction? (**SPL**).
6.3.5 What is the level of your satisfaction with the quality of the interior environment you are working in (is it dry and free from pollutants)? (**SIEQ**).
The Result Model is:

SKSU = 1.302 + (0.229 * SLGT) - (0.00607 * SWND) - (0.0876 * SCRT) + (0.0884 * SPL) + (0.116 * SORT) + (0.0163 * SIEQ)

N = 80

R = 0.267 Rsqr = 0.0714 Adj Rsqr = 0.000

Standard Error of Estimate = 0.936

Constant	Coefficient	Std.Err	t	P	VIF
SLGT	0.229	0.129	1.774	0.080	1.060
SWND	-0.00607	0.117	-0.052	0.959	1.055
SCRT	-0.0876	0.123	-0.710	0.480	1.110
SPL	0.0884	0.106	0.834	0.407	1.013
SORT	0.116	0.129	0.903	0.369	1.070
SIEQ	0.0163	0.114	0.143	0.887	1.056

Table8: Comparison between the elements of user satisfaction with the lightening and building (25).

Analysis of Variance:

	DF	SS	MS	F	P
Regression	6	4.920	0.820	0.936	0.475
Residual	73	63.968	0.876		
Total	79	68.888	0.872		

Table9: Analysis of variance between the extent of user satisfaction with lighting in buildings (25).

Throughout the results, it is concluded that they are satisfied with the methods used in directing the building in order to protect the facades from subjection to the sun beams and reduction of heat transfer from outside to insider. But we found them unsatisfied with the methods used in distributing windows in spaces they are dealing with as they are obliged to use the lightening in the day time though they are able to do without it and save the electrical energy. As for the rest of questions, we found that they are neutral.

6.4 Model about satisfaction of Usage of colors:

The questions measuring the extent of users' satisfaction with the applications of color usage include the following:

6.4.1 What is the level of your satisfaction with the used colors in your space? (**SCLR**).
6.4.2 What is the level of your satisfaction with the choice of the colors of the external facades and ceiling and the method of handling them? (**SCLO**).
6.4.3 What is the level of your satisfaction with making every façade having its uniqueness in design i.e. making everyone unlike the other? (**SODE**).
6.4.4 Do you see the importance of choosing colors and its effects are important in the interior and exterior building environment? (**SICL**).

The Result Model is:

SKSU = 2.294 - (0.0882 * SCLO) + (0.0410 * SODE) - (0.0608 * SICL) + (0.0577 * SCLR)

There are independent variables in the regression model that appear to be highly correlated with other independent variables or have no variability. These variables have been removed from the regression model. The specific variables are:

Removed SCLO because it is collinear.
Removed SODE because it is collinear.
Removed SICL because it is collinear.
N = 80
R = 0.118 Rsqr = 0.0139 Adj Rsqr = 0.000
Standard Error of Estimate = 0.952

Constant	Coefficient	Std.Err	t	P	VIF
SCLO	-0.0882	0.148	-0.597	0.553	1.052
SODE	0.0410	0.103	0.398	0.692	1.020
SICL	-0.0608	0.0939	-0.648	0.519	1.086
SCLR	0.0577	0.111	0.518	0.606	1.082

Table10: Comparison between the elements of user satisfaction on the Usage of colors (25).

Analysis of Variance:

	DF	SS	MS	F	P
Regression	4	0.955	0.239	0.264	0.900
Residual	75	67.932	0.906		
Total	79	68.888	0.872		

Table11: Analysis of variance between the extent of user satisfaction with the Usage of colors (25).

Throughout the results, we conclude that they are slightly satisfied with the methods of using colors in the internal spaces. But they were unsatisfied with the choice of colors of façades and ceiling and the method of processing it. As for the rest of questions, we found that they are neutral.
SO, if we compared the concluded results from another point of view, we can find there is a difference between the Saudi citizen and the Arabian resident in their view of sustainability and the extent of what its principles reflect if we applied it correctly. But we find through the previous studies that there are no significant differences that can be counted for any party due to the correspondence of the Arab customs that are similar to each other, besides the similarity of life styles and thought in most of its countries.

Group	N	Missing	Average	25%	75%
N-SAUDI	20	0	2.000	1.500	2.500
SAUDI	60	0	2.000	2.000	3.000

Table12: Comparison between the degree of satisfaction Saudi and non-Saudi in the ways of Sustainable Architecture (25).

Mann-Whitney U Statistic= 650.000
T = 760.000 n (small)= 20 n (big)= 60 (P = 0.556)

The difference in the average values between the two groups is not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.556)

From another perspective, if we divided the sample according to the work places that we they are working in, we will find also that there are no significant reliable differences. As we noted before, there are building codes that don't help or encourage the usage of sustainable architecture principles and methods correctly, the matter that led to the disinterest in it whether by professionals and concerned parties or by the dealers with these buildings, the matter that gave a passive reaction in the trend of this principle that must be applied in one day.

Kruskal-Wallis One Way Analysis of Variance on Ranks Data source:

Group	N	Missing	Average	25%	75%
Al Tawuniya	20	0	2.000	1.500	2.500
TWEEQ	20	0	2.000	1.000	2.500
LIBRARY	20	0	2.000	2.000	3.000
SALAM	20	0	2.000	1.500	2.500
Al Tawuniya	20	0	2.000	1.500	2.500

Table13: Comparison between the extent of user satisfaction with location (25).

H = 1.461 with 3 degrees of freedom. (P = 0.691)

The differences in the average values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.691)

Thus, we must take sustainability principles into account due to what these studies and researches indicate that these buildings harm the environment greatly and considered one of its natural resources largest consumers. Thus, professionals and workers in the field of architecture should call and work hardly to apply the sustainability principles and adoption of the concept of prevention or reduction of waste through the decisions of using building materials used before. This is in addition to the increase of the building materials efficiency, the matter that focuses on the support of the general economy of the Kingdom and enhances the development revenues.

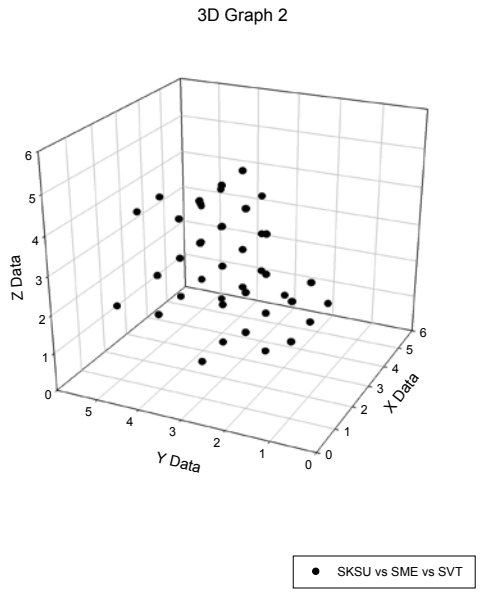

Figure23: Diagram shows how user satisfaction in terms of natural ventilation of the building (25).

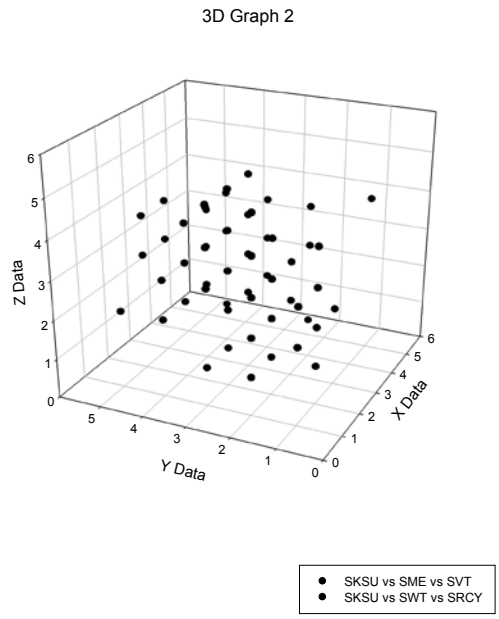

Figure24: Chart shows the level of satisfaction of users on the methods used to reduce the waste of water used in buildings (25)

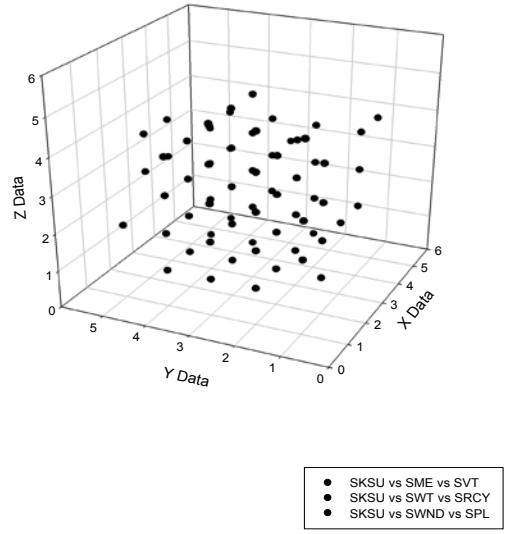

Figure25: Diagram shows how user satisfaction in terms of building heights and distances research on obscure light (25).

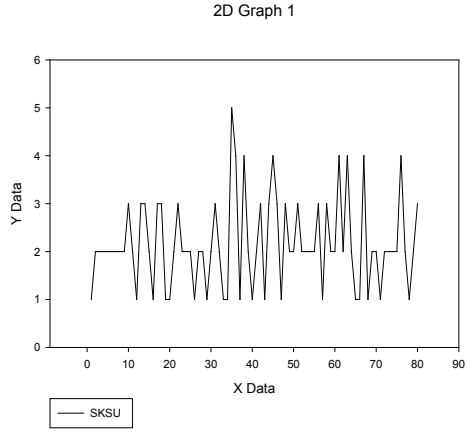

Figure26: Chart shows the level of user satisfaction in general, the methods and building practices used in the Kingdom of Saudi Arabia, which depend on design in the style of Sustainable Architecture (25).

7. Recommendations:

7.1 Developing the role, competence, and techniques of the devices responsible for sustainable applications in the kingdom of Saudi Arabia to become more interactive with the visions and innovative ideas with its ability to take advantage of the constant communication with civil community and private sector.

7.2 The importance of developing the architectural education, academic study, and interest in the environmental culture that may play a very big role in creating a generation of architectures recognizing all the developments in the global architecture, and its profit in relation with our environmental circumstances.

7.3 Stimulating and encouraging the Saudi government through supporting studies, researches, seminars, and spreading the environmental awareness (the media role) to encourage all axes related to developing the thermal performance, and providing the energy used in buildings in the light of creating low-cost alternative methods.

7.4 Developing general code for sustainable buildings in the kingdom of Saudi Arabia explaining and describing methods of implementations, and service executive processing (energy, water, lightening, sanitation...). It should be certified and safe structurally, suiting different environments of different regions in the kingdom of Saudi Arabia, and taking into account the extent of user's satisfaction.

7.5 Emphasizing the importance of achieving integration between the functionality and usufructuary performance of the building from one hand and the creative aesthetics performance on the other hand in contemporary buildings to benefit in raising the functionality and usufructuary performance level in architecture.

7.6 Choosing the construction method that achieves the functional role of the building through the consideration of the response to the climate, technology, civilization, and site. This is what the philosophy of sustainable architecture reflects.

7.7 The most important step of environmental work is to convince the customers with benefits resulting from the efficiency of environmental design.

7.8 Using contemporary building materials requiring the application of several studies and procedures that ensure its usage in an environmental framework.

7.9 Benefiting from the features of national architecture, and working on its revival because it is sustainable by its nature, and we must benefit from this architectural cultural experiment in selecting suitable materials for our climate, environment, and culture.

7.10 To achieve the best management for energy consumption in buildings, we must utilize the passive solar design (routing, insulation, shading, lightening and natural ventilation, slots processors and ceils, materials of high efficiency, etc.) to reduce reliance on mechanical and electrical systems. We must also benefit from renewable energy sources as solar energy by using positive solar systems such as photoelectric cells and thermal compounds, with the awareness of the importance of these technologies and supporting it locally for generalization.

7.11 The design must include a comprehensive plan to control energy consumption over the project stages, with the suggestion of following-up systems and monitoring this consumption after the operation building.

7.12 I recommend doing further applied studies on the sustainable buildings in the kingdom of Saudi Arabia on a larger scale and it should not be limited to office buildings, but comprising the residential buildings and other activities with comparing the results with the results of this study as they have greater understanding and greater support for the applications of sustainable architecture in the kingdom of Saudi Arabia.

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